



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/067,410	02/04/2002	Christopher W. Hill	3380.1US (97-842.1)	8302
24247	7590	07/20/2004	EXAMINER	
TRASK BRITT P.O. BOX 2550 SALT LAKE CITY, UT 84110			LEE, HSIEN MING	
			ART UNIT	PAPER NUMBER
			2823	

DATE MAILED: 07/20/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

10/067,410

Applicant(s)

HILL ET AL.

Examiner

Hsien-Ming Lee

Art Unit

2823

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 14 May 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-28 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-28 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

## Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

HSIEN-MING LEE  
PRIMARY EXAMINER

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_.

- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

## DETAILED ACTION

### Remarks

1. Claims 1-28 are pending in the application. The objection to the amendment as set forth in the previous Office Action is withdrawn in response to applicant argument filed 5/14/2004.

### *Claim Rejections - 35 USC § 112*

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claims 1 and 20 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The limitation “causing the chemical reaction” is very confusing to the examiner.

Claim 1, at lines 3-4, it recites “causing **a chemical reaction** ... to selectively deposit metal silicide.....” and then, at lines 6-7, it recites “depositing an interconnect material onto the metal silicide in situ with causing **the chemical reaction.**” (Emphasis added)

By the way it claims, it means that with the **same** chemical reaction the metal silicide and the interconnect material are formed. In claim 14, it recites that “the interconnect material comprises depositing at least one of titanium and titanium nitride.” How can a **same** chemical reaction simultaneously form totally unrelated products (i.e. metal silicide and titanium or metal silicide and titanium nitride) ? From the specification, the examiner believe that the chemical reaction relating to the formation of the interconnect material refers to  $\text{TiCl}_4 + \text{NH}_3 = \text{TiN}$  (page 10), which is different from the reaction of forming the metal silicide. On paragraph [0013] of the specification, it also states that [f]ollowing the deposition of the selective contact, and in situ

Art Unit: 2823

therewith (i.e. in the same deposition chamber), an interconnect, which is also referred to as a barrier layer, is deposited over the selective contact.” Obviously, there are two different chemical reactions for forming the metal silicide and the interconnect.

Therefore, the limitation “causing the chemical reaction” at the last line in claim 1 should have been recited as – causing a second chemical reaction – or – causing another chemical reaction --.

The above issue also appears in claim 20.

For the above reason, the limitation “causing the chemical reaction” has been treated in this Office Action based upon the best understanding of the examiner.

### ***Claim Rejections - 35 USC § 103***

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 1, 8-10, 12-20, 23 and 25-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shinriki et al. (US 6,001,729, submitted by applicant) in view of Chen et al. (US 6,020,259, submitted by applicant).

In re claims 1, 8, 14, 20, 27 and 28, Shinriki et al., in Figs. 8A-8C and related text, teach the claimed method, comprising:

- causing a chemical reaction (i.e.  $\text{TiCl}_4$  reacts with  $\text{SiH}_4$ , col. 12, lines 37-39) adjacent to a surface of one exposed, doped area 28 of a semiconductor device structure to selectively deposit metal silicide or contact material (i.e.  $\text{TiSi}_x$ ) thereon without

reacting material of the one exposed, doped area because the formation of the  $\text{TiSi}_x$  does not consume the underlying doped silicon region 28; and

- forming an interconnect material 38 (i.e. a barrier layer,  $\text{TiN}$ ) via a rapid thermal nitridation process (RTN) onto the metal silicide or the contact material insitu with causing another chemical reaction (i.e.  $\text{TiCl}_4$  reacts with nitrogen-containing ambient, col. 12, lines 41-43 and col. 11, lines 55-57).

Shinriki et al. do not teach that the interconnect material ( $\text{TiN}$ ) is formed by deposition.

Chen et al., however, teach selectively deposit a metal silicide 36 on the exposed, doped area 30 (Figs. 4-5); and CVD depositing the interconnect material 38 ( $\text{TiN}$ ) onto the metal silicide 36 (Fig.6) with causing another chemical reaction (i.e.  $\text{TiCl}_4$  reacts with  $\text{N}_2$ , col. 3, lines 20-25).

Therefore, it would have been obvious to one of the ordinary skill in the art, at the time of the invention was made, to substitute the RTN process in Shinriki et al. with CVD method of Chen et al. for depositing the interconnect material ( $\text{TiN}$ ) onto the metal silicide, since this substitution would simplify the processing step for forming the interconnect material by using the same precursor (i.e.  $\text{TiCl}_4$ ) and not heating up the substrate.

In re claims 9, 10, 25 and 26, Shinriki et al. in view of Chen et al. teach that depositing the interconnect material ( $\text{TiN}$ ) comprises blanket depositing the interconnect material (col. 3, lines 20-23, Chen et al.) and patterning the interconnect material by removing the excess interconnect material from outside of the contact hole (Figs.6-7, Chen et al.).

In re claims 12, 13 and 23, Shinriki et al. in view of Chen et al. teach depositing an electrically conductive layer over the interconnect material, i.e. layer 40 over 38 (Fig.7 in Chen

et al.) or 32 over 38 (Fig. 8D in Shinriki et al.) and patterning the electrically conductive layer by removing the excess electrically conductive layer from the outside of the contact hole.

In re claims 15-17 and 19, Shinriki et al. also teach that causing the chemical reaction comprises reacting a metallic precursor (i.e.  $\text{TiCl}_4$  or titanium tetrahalide) with a silicon-containing compound (i.e.  $\text{SiH}_4$  or silane).

In e claim 18, Shinriki et al. in view of Chen et al. further teach that depositing the interconnect material comprises reacting a metallic precursor (i.e.  $\text{TiCl}_4$ ) with a reactant comprising an activated species (i.e.  $\text{N}_2$ ) (col. 3, lines 20-24, Chen et al.).

6. Claims 2-5 and 21-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shinriki et al. in view of Chen et al. as applied to claims 1 and 20 above, and further in view of Chang et al. (US 5,043,299).

In re claims 2-4 and 21, Shinriki et al. in view of Chen et al teaches the claimed method, as stated above, but fails to teach exposing said at least one exposed, doped area of the semiconductor device structure to a plasma comprising an activated species of at least one of nitrogen, hydrogen, and ammonia; and cleaning the semiconductor device structure.

Chang et al., in an analogous art of selective deposition, teach a pre-deposition preparation by exposing the exposed, doped area of the semiconductor device structure to plasma comprising an activated species of at least one of nitrogen and hydrogen (Fig. 1 and text in col. 3, lines 14-26; col. 4, lines 10-15); and cleaning the semiconductor device structure (col.7, lines 1-11) for the purpose of removing contaminants including undesirable oxide and moisture (col.2, lines 15-28; col.6, lines 48-61).

Therefore, one of the ordinary skill in the art, at the time of the invention was made, would have been motivated to expose the exposed, doped area of semiconductor device structure of Shinriki et al. in view of Chen et al by the plasma comprising either nitrogen or hydrogen and cleaning the semiconductor device structure, as taught by Chang et al., since by doing so it would be beneficial to the subsequent selective deposition. (col.2, lines 15-28; col.6, lines 48-61, Chang et al)

In re claim 5, Shinriki et al. in view of Chen et al and further in view of Chang et al. further teach that said cleaning includes employing a cleaning agent comprising chlorine. Particularly, Chang et al. indicate using a halogen-containing gas, which at least would include chlorine and fluorine, for the cleaning purpose. (col.7, lines 5-6).

In re claim 22, Shinriki et al. in view of Chen et al and further in view of Chang et al. do not teach exposing the semiconductor device structure to a nitrogen-ammonia plasma. However, the selection of the cleaning plasma for said exposing step is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. In re Jones, 162 USPQ 224 (CCPA 1955)(the selection of optimum ranges within prior art general conditions is obvious) and In re Boesch, 205 USPQ 215 (CCPA 1980)(discovery of optimum value of result effective variable in a known process is obvious). For example, the cleaning plasma can be selected for the particular surface to be cleaned, dependent upon the material of the particular surface. (col.3, lines 14-26, Chang et al.) In this case, the applicant is required to demonstrate the criticality, generally by showing that the claimed plasma would achieve unexpected results relative to the prior art. See M.P.E.P. 2144.05 III.

Art Unit: 2823

7. Claims 6 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shinriki et al. in view of Chen et al. as applied to claim 1 above, and further in view of Kolar et al. (US 5,162,259).

Shinriki et al. in view of Chen et al. teaches the claimed method, as stated above, but fails to teach cleaning the semiconductor device structure after said depositing said metal silicide, wherein said cleaning includes employing a cleaning agent comprising at least one of chlorine, hydrochloric acid, and hydrofluoric acid.

Kolar et al. in an analogous art teach forming a silicide layer 40 followed by cleaning the semiconductor device structure employing a cleaning agent comprising hydrochloric acid, prior to depositing an interconnect material 38. (Fig.4 and text in col. 21-23)

Therefore, one of the ordinary skill in the art, at the time of the invention was made, would have been motivated to utilize said hydrochloric acid as cleaning agent as taught by Kolar et al., in the method of Shinriki et al. in view of Chen et al. to clean the surface of said deposited metal silicide and then to deposit said interconnect material, since by doing so it would improve the adhesion between adjacent layers.

8. Claims 11 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shinriki et al. in view of Chen et al. as applied to claim 1 above, and further in view of Kim et al. (US 5,821,164).

Shinriki et al. in view of Chen et al. do not teach selectively depositing the interconnect material (TiN).

However, using selective deposition for forming TiN in a contact hole has been widely used in the art, as evidenced by Kim et al. (col. 4, lines 24-27).



Therefore, it would have been obvious to one of the ordinary skill in the art, at the time the invention was made, to use the selective deposition, as taught by Kim et al., for forming the interconnect material of Shinriki et al. in view of Chen et al, since by this manner it would a better means for controlling the desired location and thickness of the interconnect material.

***Conclusion***

9. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-Ming Lee whose telephone number is 571-272-1863. The examiner can normally be reached on Tue-Thu between 8:00 a.m. and 6:00 p.m..

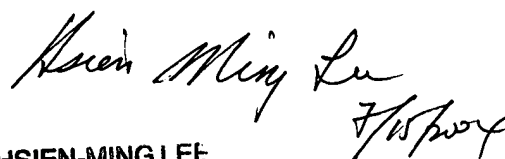
If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 571-272-1855. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Art Unit: 2823

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Hsien-Ming Lee  
Primary Examiner  
Art Unit 2823

July 15, 2004

  
HSIEN-MING LEE  
PRIMARY EXAMINER